REMARKS

Claims 10-17 are presently pending in the application. Claims 5-9 have been cancelled without prejudice to the filing of a divisional application directed to the subject matter thereof.

The Examiner has objected to the Abstract of the Disclosure section asserting that it should be in narrative form and generally limited to a single paragraph on a separate sheet within the range of 50 to 150 words. Applicant has elected to delete the entire Substitute Specification, page 1, line 1, through page 7, line 14, including the Abstract of the Disclosure section, page 10, lines 1-17, and substitute therefore a Second Substitute Specification in order to correct typographical errors as well as sentences and paragraphs that were mistakenly repeated. A marked-up or comparative copy of the Specification, including the Abstract, showing the changes made thereto is also enclosed to reflect these amendments. Since these amendments are formal in nature, no new matter has been added by the Second Substitute Specification. Entry of the Second Substitute Specification, and reconsideration and withdrawal of the Examiner's objection to the Abstract of the Disclosure, are respectfully requested.

The Examiner has rejected claims 1-4 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point and distinctly claim the subject matter which Applicant regards as the invention. Applicant has cancelled claims 1-4 and added new claims 10-17 in order to claim additional preferred features of the present invention and to obviate the Examiner's §112 rejections. Support for new claim 10 can be found, for example, in original claims 1 and 5, for example. Support for claim 11 can be found in original claim 2, for example. Support for new claim 12 can be found, for example, at paragraph [0004] of the specification. Support for claims 13 and 14 can be found, for example, at paragraph [0019] of the specification. Support for claim 15 can be found, for example, in original claim 3. Support for claim 16 can be found, for example, in original claims 4 and 8. Support for claim 17 can be found, for example, in original claim 9. No new matter has been added by new claims 10-17, and it is believed that the new claims obviate all of the Examiner's §112 rejections of claims 1-4. Accordingly, reconsideration and withdrawal of the §112 rejections, and entry of new claims 10-17 are respectfully requested.

The Examiner has rejected claims 1-4 under 35 U.S.C. §102(b) as being anticipated by U.S. Patent No. 4,590,669 of Imamura ("Imamura"). The Examiner contends that

Imamura teaches a method of making a temperature sensor comprising the steps of: connecting a pair of wires 6 of a cable 7 to a sensor 1; and, overmolding the sensor and the exposed wires with an inorganic adhesive as shown in Figs. 1-5 of Imamura. With regard to claim 2, the Examiner asserts that Imamura discloses in Fig. 2 an outer sheath 24 enclosing the sensor and the exposed wires. Also, with regard to claims 3 and 4, the Examiner asserts that Imamura discloses in Fig. 4 a covering tube 23 enclosing the sensor and the exposed wires, and a ramming treatment for a pressure welding.

Applicant traverses the Examiner's §102 rejection and the arguments in support thereof, to the extent that they may be found to apply to new claims 10-17, for the reasons that follow.

Section 102 requires that each element as set forth in a particular claim be found, either expressly or inherently, in a single prior art reference. The present invention claims a method for manufacturing a temperature probe comprising a cable having at least one pair of conducting wires, each conducting wire of the pair being insulated by a sheath of insulating material and having at one end of the cable an exposed length of wire with a sensor soldered to the exposed lengths of wire, the method comprising the steps of: introducing the sensor and the exposed lengths of wire into a covering element comprising a first thermoplastic material which is the same as or compatible with the insulating material, and covering the sensor and the exposed lengths of wire by overmolding the sensor and the exposed lengths with a second thermoplastic material which is the same as or compatible with the insulating material (claim 10).

In contrast, Imamura is directed to a method of preparing a resistance thermometer having a resistance temperature detector (RTD) element supported within metallic sheaths by an insulating material such that the thermometer is manufactured by connecting two tubular metallic sheaths in series by pressure welding (Abstract). The metallic sheaths are preferably made of stainless steel (see col. 3, lines 12-13 and 42-43). The electrical conductors 7 are retained within the first sheath 21 by the insulating material, which is a refractory material 9 of, for example, finely pulverized magnesium oxide (see col. 3, lines 14-18). The conductors are connected to terminal leads 5 of the RTD element 1 through intermediate connecting wires 6 (see col. 3, lines 18-20 and Fig. 1).

Further, a metallic ring 23 is put on the first portion 21a of the first sheath 21 and a second sheath 24 is attached thereto (see col. 3, lines 49-54 and Figs. 2-3). The assembly comprising the first sheath 21, the ring 23 and the second sheath 24 is subjected to a pressure welding treatment for integrally and firmly connecting the first and second metallic sheaths 21, 24 together (see col. 4, lines 3-6). The pressure welding treatment is effected by ramming or striking the ram head 26 repeatedly against the metallic ring 23, while continuously or intermittently, rotating the assembly on a die 27 (col. 4, lines 7-12). The ramming treatment deforms the ring 23 and fills the space in the groove 22 thereby pressure welding both sheaths 21, 24 such that they are integrally connected with each other (col. 4, lines 12-16). This method of joining metallic sheaths solves the technical problem associated with arc welding sheaths which can cause melting of the conductors 7 and intermediate connecting wires 6 resulting in electrical disconnection between the RTD element 1 and the circuitry (col. 1, lines 58-64).

Imamura does not teach introducing a sensor and exposed lengths of wire into a covering element comprising a first thermoplastic material which is the same as or compatible with insulating material of a sheath which insulates each conducting wire (see claim 10). Also, the pressure welding treatment described in Imamura is different from the overmolding described in the present invention. Further, Imamura does not teach, either expressly or inherently, covering the sensor and the exposed lengths of wire by overmolding the sensor and the exposed lengths with a second thermoplastic material which is the same as or compatible with the insulating material (see claim 10).

Since Imamura does not teach each element set forth in claim 10, either expressly or inherently, Imamura does not anticipate the present invention. Further, since new claims 11-17 depend from claim 10, either directly or indirectly, claims 11-17 are also not anticipated by Imamura.

In view of the forgoing amendments and remarks, Applicant submits that new claims 10-17 comply with the requirements of § 112 and are patentably distinct from the prior

art. Accordingly, reconsideration and withdrawal of the rejections, and an early Notice of Allowance are respectfully requested.

Respectfully submitted,

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6/2/03 By: Will C. Youngblood

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Marked-Up Version of Second Substitute Specification

Marked up Copy

~~- -~~TITLE OF THE INVENTION

[0001] Method For Manufacturing A Sealed Temperature Probe And Probe Thus Manufactured

BACKGROUND OF THE INVENTION

[0002] The present invention relates to temperature probes of the electric type, and in particular to a method for manufacturing a sealed probe as well as to a probe manufactured according to said method.

[0003] It is known that a temperature probe of electric type consists of an insulated cable including one or more pairs of conducting wires suitable to transmit the electric signals coming from a sensor member soldered at the end of said wires. For a correct and reliable operation of the probe it is essential that the sensor be perfectly insulated from the environment. To this purpose, the probe terminal where the wires are soldered to the sensor must be sealed onto the insulated cable so as to achieve a continuity of insulation.

[0004] In known probes this sealing is carried out in two ways, namely through a resin covering or through an ~~overmoulding~~overmolding of the sensor with the same thermoplastic material of which the outer sheath of the cable is made (or with another material compatible therewith, i.e. capable of melting and mixing therewith).

[0005] In the first case, the resin covering does not guarantee a perfect long-term sealing when the probe undergoes repeated thermal cycles, in particular when it is used for measurements in cold environments. In fact, since it is a material having a thermal expansion coefficient different from that of the cable sheath a detachment is inevitably reached. This implies the possibility that the condensate forming on the cable penetrates the probe terminal causing a malfunctioning.

[0006] In the second case, this problem is overcome in that, by using the same material ~~there is achieved a~~, perfect sealing is achieved thanks to the fusion of the covering with the cable sheath. However, even this solution has various drawbacks given ~~by~~ the difficulty of ~~moulding~~molding the covering.

[0007] First of all, the standards require the insulating covering of the sensor to have an established minimum thickness and in order to have an adequate certainty that said minimum

value is achieved it is necessary to ~~mould~~mold a covering of a significantly greater thickness. This results from the fact that the sensor is very small and light and the wires to which it is soldered are flexible, whereby it can easily move from the central position inside the ~~mould~~mold upon injection of the thermoplastic material. The greater thickness should thus compensate for a possible eccentricity of the sensor, which is also limited as far as possible through complicated injection balancing systems and by keeping the covering as short as possible.

[0008] As a consequence, the probe thus manufactured necessarily has a terminal of short length and a diameter greater than the minimum which could be achieved according to the standards, and it requires the use of complicated and expensive ~~moulding~~molding systems. Moreover, this solution still does not allow ~~to have the~~ with absolute certainty, that the thickness is as required.

~~[0009] A further drawback stems from the fact that in order to obtain a double insulation with two layers of different material and/or colour it is necessary to carry out a double moulding. This obviously implies higher costs and a further increase in diameter. The present invention relates to temperature probes of electric type, and in particular to a method for manufacturing a sealed probe as well as to a probe manufactured according to said method.~~

~~[0010] It is known that a temperature probe of electric type consists of an insulated cable including one or more pairs of conducting wires suitable to transmit the electric signals coming from a sensor member soldered at the end of said wires. For a correct and reliable operation of the probe it is essential that the sensor be perfectly insulated from the environment. To this purpose, the probe terminal where the wires are soldered to the sensor must be sealed onto the insulated cable so as to achieve a continuity of insulation.~~

~~[0011] In known probes this sealing is carried out in two ways, namely through a resin covering or through an overmoulding of the sensor with the same thermoplastic material of which the outer sheath of the cable is made (or with another material compatible therewith, i.e. capable of melting and mixing therewith).~~

~~[0012] In the first case the resin covering does not guarantee a perfect long-term sealing when the probe undergoes repeated thermal cycles, in particular when it is used for measurements in cold environments. In fact, since it is a material having a thermal expansion coefficient different from that of the cable sheath a detachment is inevitably reached. This implies the possibility that the condensate forming on the cable penetrates the probe terminal causing a malfunctioning.~~

~~[0013] In the second case this problem is overcome in that by using the same material there is achieved a perfect sealing thanks to the fusion of the covering with the cable sheath. However even this solution has various drawbacks given by the difficulty of moulding the covering.~~

~~[0014] First of all, the standards require the insulating covering of the sensor to have an established minimum thickness and in order to have an adequate certainty that said minimum value is achieved it is necessary to mould a covering of a significantly greater thickness. This results from the fact that the sensor is very small and light and the wires to which it is soldered are flexible, whereby it can easily move from the central position inside the mould upon injection of the thermoplastic material. The greater thickness should thus compensate for a possible eccentricity of the sensor, which is also limited as far as possible through complicated injection balancing systems and by keeping the covering as short as possible.~~

~~[0015] As a consequence, the probe thus manufactured necessarily has a terminal of short length and a diameter greater than the minimum which could be achieved according to the standards, and it requires the use of complicated and expensive moulding systems. Moreover, this solution still does not allow to have the absolute certainty that the thickness is as required.~~

[0009] ~~[0016]~~ A further drawback stems from the fact that in order to obtain a double insulation with two layers of different material and/or ~~colour it is necessary to carry out a double moulding.~~ color it is necessary to carry out a double molding. This obviously implies higher costs and a further increase in diameter.

BRIEF SUMMARY OF THE INVENTION

[0010] ~~[0017]~~ Therefore, the object of the present invention is to provide a probe and a manufacturing method which overcome said drawbacks. This object is achieved by introducing the sensor, prior to the ~~overmoulding~~overmolding step, into a covering element which assures the required minimum thickness.

[0011] ~~[0018]~~ A first fundamental advantage of the present invention is therefore that of obtaining a probe in which the minimum thickness of the sensor insulating covering is guaranteed, and furthermore without requiring complicated injection balancing systems.

[0012] ~~[0019]~~ A further advantage stems from the fact that the probe thus obtained has a terminal of the smallest diameter possible which can also be longer without implying any

manufacturing difficulty. In other words, there is greater freedom in the choice of the terminal size.

[0013] ~~[0020]~~ Still another advantage is given by the possibility of easily obtaining a double insulation with different layers through a single manufacturing step and without an excessive increase in diameter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0014] ~~[0021]~~ The foregoing summary, as well as the following detailed description of preferred embodiments of the invention, will be better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, there is shown in the drawings embodiments which are presently preferred. It should be understood, however, that the invention is not limited to the precise arrangements and instrumentalities shown.

[0015] ~~[0022]~~ In the drawings:

[0016] ~~[0023]~~ Fig. 1 is a partial longitudinal sectional view of the terminal of a probe according to the invention, in a first embodiment thereof; and

[0017] ~~[0024]~~ Figs. 2, 3, 4 and 5 are views similar to the preceding view of other four embodiments of the present probe.

DETAILED DESCRIPTION OF THE INVENTION

[0018] ~~[0025]~~ With reference to said ~~figures~~Figures, there is seen that a probe according to the invention conventionally includes a cable C provided with an outer insulating sheath G which encloses at least a pair of conducting wires F, insulated in turn by respective inner sheaths P, which end with an exposed length where a sensor S is soldered.

[0019] ~~[0026]~~ The novel aspect of the present probe is the presence of a covering element into which sensor S is introduced prior to the injection ~~moulding~~molding of the thermoplastic material M. In practice, the covering element is then fused together with material M to form a single body with sheath G, so as to assure a perfect sealing.

[0020] ~~[0027]~~ In the embodiment of ~~fig~~Fig. 1, the simplest, the covering element consists of the end portion of the outer sheath G which is pushed forward. In other words, sensor S is first soldered to wires F, then sheath G is slid along the inner sheaths P until it encloses sensor S; finally the probe terminal is placed in the ~~mould~~mold and material M is injected to fill the end portion of sheath G and form a closure plug.

[0021] ~~[0028]~~ This simple and effective solution has, however, some limits, namely that sensor S has a size smaller than the inside diameter of sheath G and that the latter has a thickness equal to or greater than the required minimum thickness of the insulating covering. Moreover, it is obvious that such a solution is not applicable in the case of cables without outer sheath G, i.e. in case there are only the two sheaths P (possibly joined or not).

[0022] ~~[0029]~~ In order to overcome said limits the covering element may be a separate member, i.e. essentially a tube extending at least sufficiently to enclose sensor S and the exposed length of wires F, such as tube N in ~~fig~~Fig. 2, but which can even be sufficiently long as to slip on cable C, as tube L in ~~fig~~Fig. 3.

[0023] ~~[0030]~~ In practice, sensor S is introduced into the covering tube prior to being placed in the ~~mould~~mold, which then retains the tube in position during the injection of material M. The blocking of the tube can be achieved in various ways, the simplest being an interference between the tube and the ~~mould~~mold, e.g. using a tube of oval cross-section in a ~~mould~~mold of circular cross-section or vice versa (this blocking requirement is obviously absent in the first embodiment described above).

[0024] ~~[0031]~~ Moreover, it is clear that in this case material M extends up to externally coating the end portion of sheath G so as to achieve a perfect sealing between the tube and the sheath thanks to the fusion of said two elements into a single body. In this regard, it should be noted that the tube may be either of the same material of sheath G or of another material compatible therewith, as previously said for material M.

[0025] ~~[0032]~~ The use of a separate tube as covering element makes it possible to easily obtain ~~a~~ multiple ~~insulation~~insulations with two or more different layers, as shown in ~~figs~~Figs. 4 and 5. In fact, by applying the same method described above it is sufficient to use a tube with at least two layers consisting of an outer material (N', L') and an inner material (N", L") coupled so as to form a single element. In this way the increase in diameter of the probe terminal is the smallest possible in compliance with the standards.

[0026] ~~[0033]~~ It should be noted that though ~~figs~~Figs. 2-5 show a cable provided with an outer sheath G, what is said above also applies to the above-mentioned case of a cable provided with the individual sheaths P only. Furthermore, it is clear that shapes, sizes and materials of the above-described elements (in particular of tubes N, L) may freely change according to the specific needs of the application for which the probe is intended. For example, the inner material

(N'', L'') of a two-layer tube could also be not compatible with material M, since it is sufficient to have the compatibility of the outer material (N', L') enclosing it. ~~With reference to said figures, there is seen that a probe according to the invention conventionally includes a cable C provided with an outer insulating sheath G which encloses at least a pair of conducting wires F, insulated in turn by respective inner sheaths P, which end with an exposed length where a sensor S is soldered.~~

~~[0034] The novel aspect of the present probe is the presence of a covering element into which sensor S is introduced prior to the injection moulding of the thermoplastic material M. In practice, the covering element is then fused together with material M to form a single body with sheath G, so as to assure a perfect sealing.~~

~~[0035] In the embodiment of fig.1, the simplest, the covering element consists of the end portion of the outer sheath G which is pushed forward. In other words, sensor S is first soldered to wires F, then sheath G is slid along the inner sheaths P until it encloses sensor S; finally the probe terminal is placed in the mould and material M is injected to fill the end portion of sheath G and form a closure plug.~~

~~[0036] This simple and effective solution has however some limits, namely that sensor S has a size smaller than the inside diameter of sheath G and that the latter has a thickness equal to or greater than the required minimum thickness of the insulating covering. Moreover it is obvious that such a solution is not applicable in the case of cables without outer sheath G, i.e. in case there are only the two sheaths P (possibly joined or not).~~

~~[0037] In order to overcome said limits the covering element may be a separate member, i.e. essentially a tube extending at least sufficiently to enclose sensor S and the exposed length of wires F, such as tube N in fig.2, but which can even be sufficiently long as to slip on cable C, as tube L in fig.3.~~

~~[0038] In practice, sensor S is introduced into the covering tube prior to being placed in the mould, which then retains the tube in position during the injection of material M. The blocking of the tube can be achieved in various ways, the simplest being an interference between the tube and the mould, e.g. using a tube of oval cross section in a mould of circular cross section or vice versa (this blocking requirement is obviously absent in the first embodiment described above).~~

~~[0039] Moreover, it is clear that in this case material M extends up to externally coating the end portion of sheath G so as to achieve a perfect sealing between the tube and the sheath thanks to the~~

~~fusion of said two elements into a single body. In this regard, it should be noted that the tube may be either of the same material of sheath G or of another material compatible therewith, as previously said for material M.~~

~~[0040] The use of a separate tube as covering element makes possible to easily obtain a multiple insulation with two or more different layers, as shown in figs.4 and 5. In fact, by applying the same method described above it is sufficient to use a tube with at least two layers consisting of an outer material (N'; L') and an inner material (N''; L'') coupled so as to form a single element. In this way the increase in diameter of the probe terminal is the smallest possible in compliance with the standards.~~

~~[0041] It should be noted that though figs.2-5 show a cable provided with an outer sheath G, what said above also applies to the above-mentioned case of a cable provided with the individual sheaths P only. Furthermore it is clear that shapes, sizes and materials of the above described elements (in particular of tubes N, L) may freely change according to the specific needs of the application for which the probe is intended. For example, the inner material (N''; L'') of a two-layer tube could also be not compatible with material M, since it is sufficient to have the compatibility of the outer material (N'; L') enclosing it.~~

[0027] ~~[0042]~~ It will be appreciated by those skilled in the art that changes could be made to the embodiments described above without departing from the broad inventive concept thereof. It is understood, therefore, that this invention is not limited to the particular embodiments disclosed, but it is intended to cover modifications within the spirit and scope of the present invention as defined by the appended claims.

- -ABSTRACT OF THE DISCLOSURE

A method for manufacturing a sealed temperature probe, including a cable (C) provided with at least a pair of conducting wires (F) insulated by respective sheaths (P) and ending with an exposed length where a sensor (S) is soldered, provides the introduction of the sensor (S) and exposed length of wires (F) into a covering element prior to the ~~overmoulding~~overmolding of the probe terminal with a thermoplastic material (M) same as or compatible with the material of the sheaths (P). In the probe thus manufactured the covering element may be either the end portion of an outer sheath (G) or a covering tube (N), possibly long enough to be slipped on the cable (C) and/or made with two layers of different materials coupled so as to form a single element. ~~A method for manufacturing a sealed temperature probe, including a cable (C) provided with at least a pair of conducting wires (F) insulated by respective sheaths (P) and ending with an exposed length where a sensor (S) is soldered, provides the introduction of the sensor (S) and exposed length of wires (F) into a covering element prior to the overmoulding of the probe terminal with a thermoplastic material (M) same as or compatible with the material of the sheaths (P). In the probe thus manufactured the covering element may be either the end portion of an outer sheath (G) or a covering tube (N), possibly long enough to be slipped on the cable (C) and/or made with two layers of different materials coupled so as to form a single element.~~ - -